

NER Combined UHV and Liquid Phase Processing (CULP) of Self-Assembled Nanostructures and Novel Interfaces, Raymond T. Tung, Brooklyn College, DMR-0303833

This work explores the possibility of using a thin liquid film to fabricate semiconductor, metallic, and oxide nanoparticles. The co-condensation of chemically inert gas molecules such as C_2F_6 and the use of processing conditions above the triple-point pressure and temperature of the gas allowed self-assembly of co-deposited material in the liquid phase into nanoscale particles.

Nanoparticles can indeed be fabricated by this method. Fig. 1b shows the morphology of nickel nanodots (total thickness ~ 1 nm), with diameters of 20-120 nm, fabricated on a clean silicon surface. Processing parameters were found to affect the density and size of the nanodots, as shown in Figs. 1a & 1b. In addition, the surface was also found to affect the self-assembly process, as shown in Fig. 1c, the morphology of which is likely the result of surface tension of the partially dried liquid film (droplets). Figure 2 shows the necessity of the liquid phase in the self-assembly of nanodots.

This work illustrated the feasibility of the fabrication of nanoparticles by the CULP technique and the self-alignment of nanoparticles to surface features. Even though the CULP procedures are tedious, its ability to fabricate nanoparticles of a wide range of materials makes it an attractive technique for niche applications. A result discovered in the present work is that a buffered and dilute condensation of a thin layer, without going through the liquid phase, could lead to an essentially continuous film, upon the desorption of the gas. This could have implications for molecular and organic electronics, e.g. as a novel method for “soft contact” fabrication.

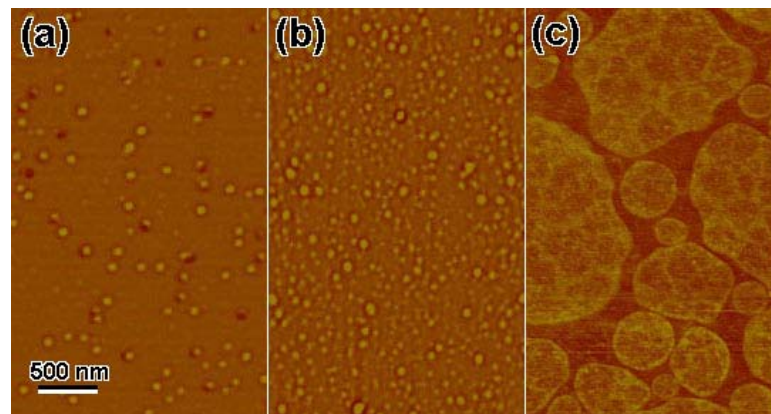


Fig. 1 AFM images of nickel nanostructures processed by the CULP method on Si (a) a layer of low-density nanodots fabricated with a dilute condensation film of Ni and C_2F_6 (b) layer of high density nanodots fabricated from a film with a higher concentration of Ni (c) structure fabricated with same conditions as b, but on a Si surface pre-coated with Ni.

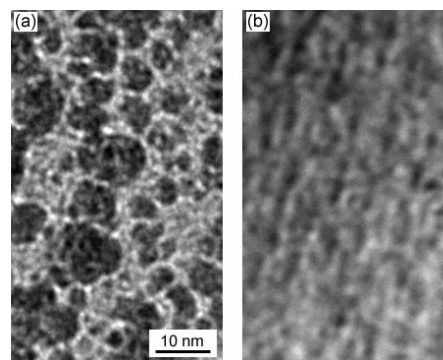


Fig. 2 TEM images of thin cobalt layers. (a) nano-dots with CULP processing (b) structure grown under same conditions but without going through the liquid phase. No nano-dots formed in (b), although the structure is not uniform. Note the higher magnification of these images as compared to Fig. 1.

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Education:

This work involves the collaboration of one graduate student (Samil Emre Ogun) and one undergraduate student (Alan Guy) and Brooklyn College, and a collaborator, Prof. C. H. Chen of the Center for Condensed Matter Science at National Taiwan University. Prof. Chen's group has many graduate and undergraduate students, albeit not funded by this program.

Outreach:

The PI participates in BC's Minority Access to Research Centers (MARC) program. The basic ideas behind this research project have been posted on the PI's website, along with a tutorial on interface electronic properties. In addition, the PI has given an informal presentation of this and other similar topics at a lunch time meeting of undergraduate students.